Application of Inside-Outside Inversion Transform Models

Transforming Space Probes !?

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1 Current Status and Previous Research

"Inside-outside inversion transform models"
A figure with the following properties is called "Inside-outside inversion transform model".
Cut a shape into several pieces.
Connect the vertices and winding the pieces in a certain direction transforms them into a different shape.
Also, after winding them, the boundary of the original shape, and the boundary of the new shape is entirely made up of the interior of the original shape.

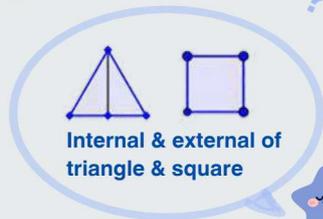**"Tile theorem"**

Can undergo inside-out transformation ➡ The model can be tiled

How to draw the lines of Dudeney's puzzle

Internal & external of triangle & square

Construction √√3 ▶ suffice!

We proved that √√3 can be constructed
▼
This can be constructed

Demands for probes
- weight reduction
- potential for life ▶high demands
- ▶▶▶ nearly identical topography

2 Methods

Three different shapes

Three-dimensional

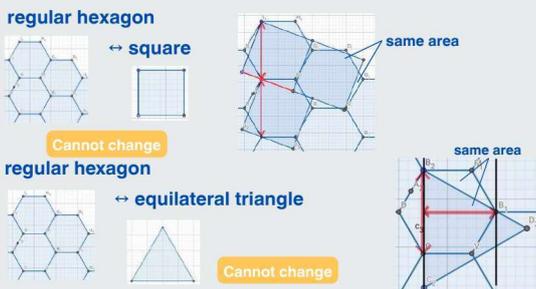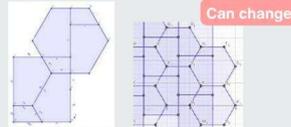Considering regularities

Designing Probes

3 Hypothesis

1 In two dimensions, it is possible to transform a shape into three different shapes.

2 In three dimensions, it is possible to transform a shape into two different shapes using the transformation method derived in two dimensions.
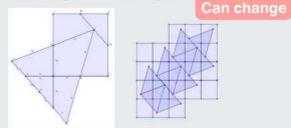
4 Research

1 Based on "Tile theorem"

Models are not able to be tiled
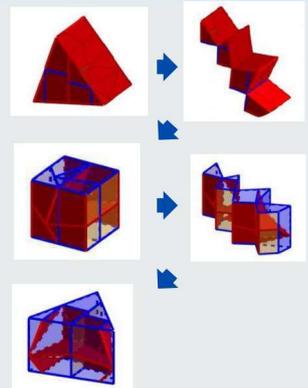➡ Cannot undergo inside-out transformation

regular hexagon ↔ square

Cannot change

regular hexagon ↔ equilateral triangle

Cannot change

same area

same area

regular hexagon ↔ rectangle — Can change

rectangle ↔ triangle — Can change

regular hexagon ↔ triangle — Can change

2

We were able to achieve it in two stages by applying the cross-sectionnes from two dimensions.

5 Proposal

Solar panels

Walking around

Transforming some ways

Various terrains

Demands & Merits

Lightweight · affordable
No waste
Same materials → Multiple uses

Other ways to use
- Environmental sample collection
- Artificial Ecological Structures

For example

References and Acknowledgments

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J. Akiyama and G. Nakamura, Determination of All Convex Polygons which are Chameleons, IEICE Transactions, E86-A, 978-986 (2003)
J. Akiyama and G. Nakamura : "Congruent Dudeney dissections of triangles and quadrilaterals" , Algorithms and Combinatorics 25, 43-73 (2003)
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